External Wireless Communications (EWC) Coverage Expansion Boom Interface Control Document (ICD)

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Contract NNJ10GA35C

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leidos

External Wireless Communications (EWC) Coverage Expansion Boom Interface Control Document (ICD)

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Contract NNJ10GA35C

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Preface

This Interface Control Document (ICD) has been developed using SSP 41174, International Space Station (ISS) Interface Control Working Group (ICWG) Operating Procedures, as a general guide.

This document defines the physical and functional interfaces between the external wireless communications coverage expansion boom and any future payload items that may be installed on the scarred locations on the boom.The long boom subassemblies will be launched soft stowed in a bag and assembled in the ISS via Intravehicular Activity (IVA). The assembly will include two sections of the boom and a built-to-print Active Work Site Interface (AWIF) probe. The installation of the final assembly to the ISS Truss location is designated as a free-float Extra Vehicular Activity (EVA) worksite activity. Once installed on the truss, the interfaces on the Long Boom may be used for attachment of future Orbital Replacement Units (ORUs) to either the Television Camera (TVC) Mounting Slide interface (e.g., an External High Definition Camera [EHDC] or similar ORU) or to future OIHs installed at the seat track interfaces.

This document will be issued as a complete revision. Proposed changes to this document must be submitted to the Program Manager along with supportive material justifying the proposed change. Comments or questions concerning this document and proposed changes shall be addressed to:

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1.1 INTRODUCTION

1.2 Purpose and Scope

This document defines and controls the physical and functional interfaces between the External Wireless Communications Coverage Expansion (EWCCE) boom and any payload that is planned to be installed on the scarred locations on the boom. The hardware will be referenced as EWCCE boom or simply boom in this document.

The boom is comprised of two short boom sections,the upper boom and the lower boom, an Active Worksite Interface (AWIF) and two mounting plates. The boom will be launched soft stowed in a bag and assembled in the Internation Space Station (ISS) via IVA. The assembly will include two sections of the boom and a built-to-print AWIF. The installation of the final assembly to the ISS Truss location is designated as a free-float EVA worksite activity. Once installed on the truss, the interfaces on the Long Boom may be used for attachment of future Orbital Replacement Units (ORUs) to either the Television Camera (TVC) Mounting Slide interface (e.g., an External High Definition Camera [EHDC] or similar ORU) or to future On-orbit Installed Hand-rails (OIHs) installed at the seat track interfaces.

Compliance with this Interface Control Document (ICD) will ensure compatibility and successful integration of the hardware.

1.3 Precedence

Technical content of this document includes applicable documents, physical, functional, and mechanical interfaces. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superceding requirement.

1.4 Responsibility and Change Authority

This ICD and associated changes are to be approved by the program manager.

1.4.1 Document Change Control

This document is maintained by the Leidos Company Cargo Mission Contract (CMC) Systems Engineering group under contract NNJ10GA35C. The hardware will be sustained by the Leidos Company Cargo Mission Contract. The changes will only be made to this document with approval from the EWCCE Boom Project Manager.

1.4.2 Points of Contact

The following Point of Contact (POC) represents the technical authority in charge of technical requirements and will act as focal point for discussions on all hardware interface related matters.

	EWCCE Boom Project Manager
Name	Paul A. Caradec
Boom Developer Organization	Cargo Mission contract, Leidos
Contact information	paul.caradec@leidos.com

2.1 DOCUMENTS

2.2 Applicable Documents

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The documents listed in this paragraph are applicable to the extent specified herein. Inclusion of applicable documents herein does not in any way supersede the order of precedence identified in section 1.2.

Document No.	Document Title
CMC2-00226	Structural Verification Plan for Common Communications for Visiting Vehicles (C2V2) Antenna Assemblies (CAAs) Under Space Station Change Notice (SSCN) 013314, Revision A

2.3 Reference Documents

The following documents contain supplemental information to guide the user in the application of this document. These reference documents may or may not be specifically cited within the text of this document.

Document No.	Document Title
CMC2-00679	Thermal Analysis for the External Wireless Communications (EWC) Coverage Expansion Boom
CMC2-00678	Structural Analysis and Mass Properties for the External Wireless Communications (EWC) Coverage Expansion Boom
CMC2-00680	Project Requirements and Verification Document Plan and Report for the Long Boom under Space Station Change Notice (SSCN) 015344
SSP 47114	International Space Station (ISS) interface Control Working Group (ICWG) Operating Procedures

2.4 Applicable Drawings

The drawings listed in this paragraph are applicable to the extent specified herein. Inclusion of applicable drawings herein does not in any way supersede the order of precedence identified in paragraph 1.2.

Drawing Number	Drawing Title
SGG33125261	INSTALLATION, LONG BOOM ASSEMBLY
SEG33125270	MOUNTING BRACKET ASSEMBLY, BOOM
SEG33125266	BOOM ASSEMBLY
SEG33125263	LONG BOOM ASSEMBLY
SEG33106351	HANDRAIL ASSEMBLY - OIH

SDG33125271	PLATE ASSEMBLY, BOOM
683-11167	BRACKET, HANDRAIL
SDG33125268	BOOM ASSEMBLY
SDG33125265	DECAL BOOM

The Slide Receptacle Assembly that interfaces with the Mounting Plate-Slide Rail Assembly is shown below in Figure 2-1.

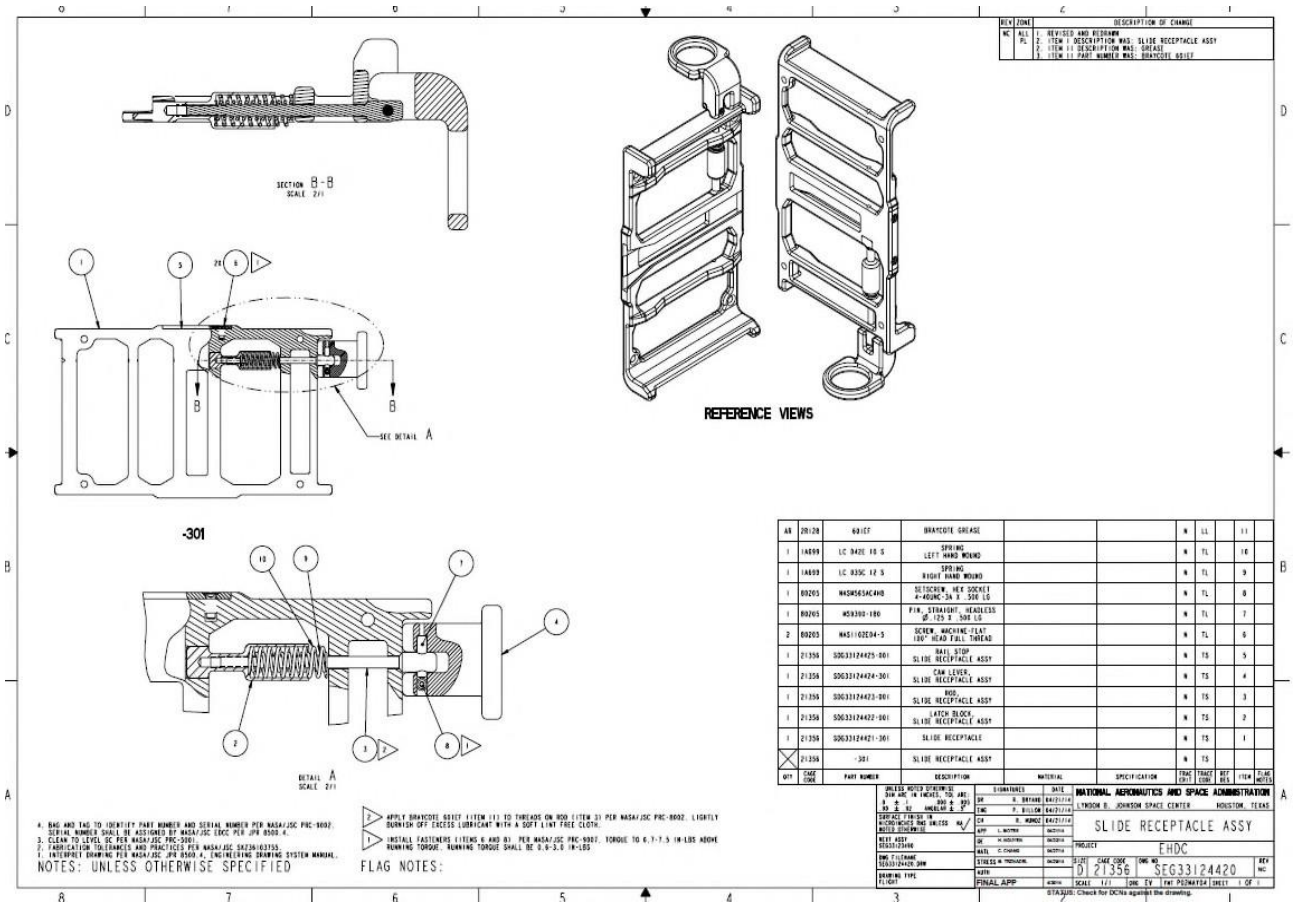


Figure 2-1 Slide Receptacle Assembly

3.1 INTERFACES

3.2 General

3.2.1 Hardware Description

The general description of the boom hardware is provided below along with its interfaces to the payload. The Long Boom Assembly is shown in Figure 3-1. The payloads are attached to the Boom Mounting Bracket Assembly. The WIF probe and the upper and lower booms are assembled via IVA and then installed on Worksite Interface (WIF) sockets on S3 and P3 long spacers.

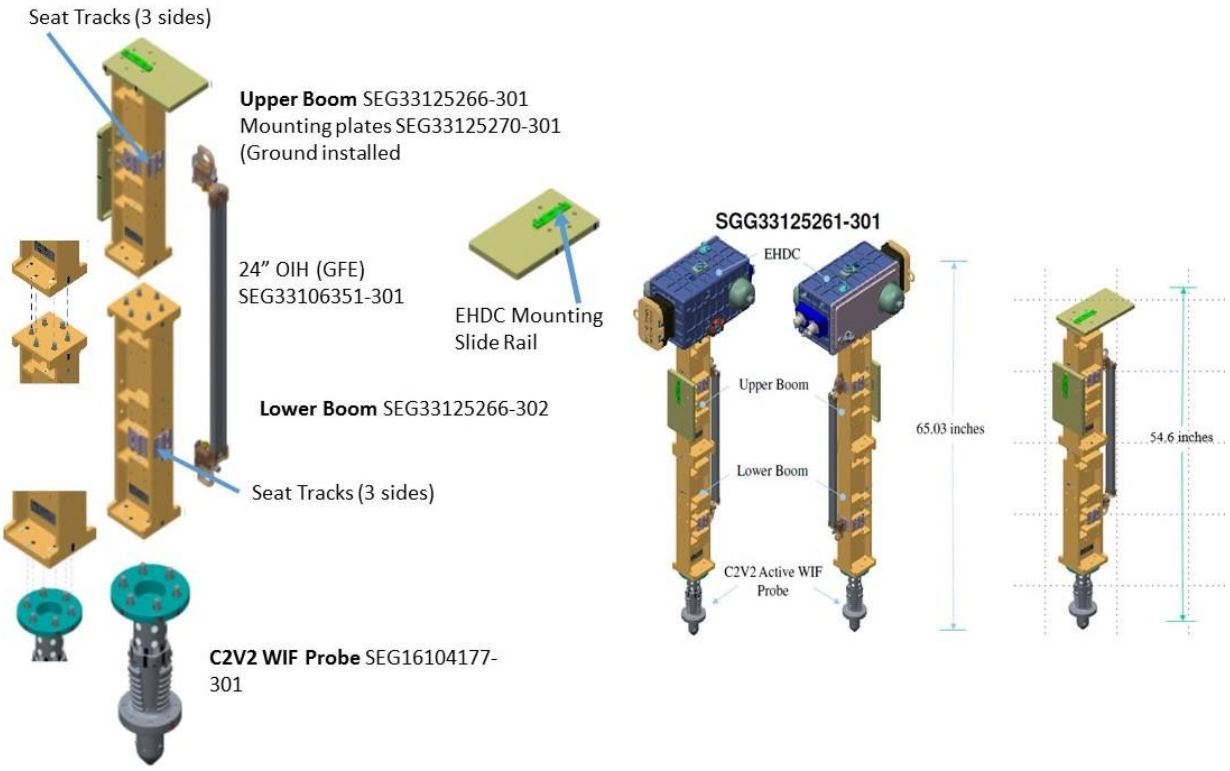


Figure 3-1 Boom Assembly Current Configuration

3.2.2 Hardware Description-Future Configuration

A second EHDC and one or two additional hand rails may be installed on the boom in the future. The EDHC mounting plate allows installation of an EHDC or a future payload that has the mounting bracket interface. Additional hand rails may also be installed on the seat tracks provided. A typical future configuration of the boom assembly is shown in Figure 3-2.

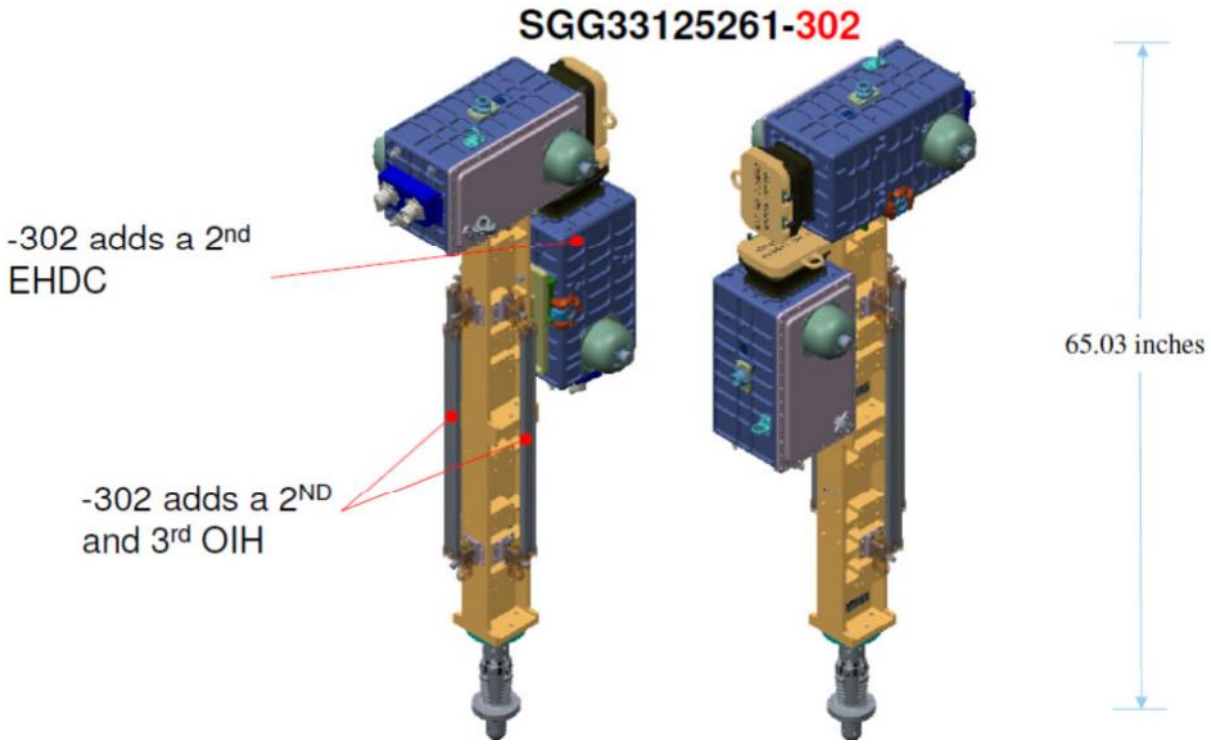


Figure 3-2 Boom Assembly-Future Configuration-2 EHDCs

3.2.3 Interface Description

3.2.3.1 Physical Interfaces

The boom assembly provides interfaces for installing:

a. One additional EHDC
b. Two additional On-orbit Installed Hand-rails(OIH)

The -301 configuration will be scarred with the interface hardware to allow EVA installation of these items on-orbit as shown in Figure 3-3.

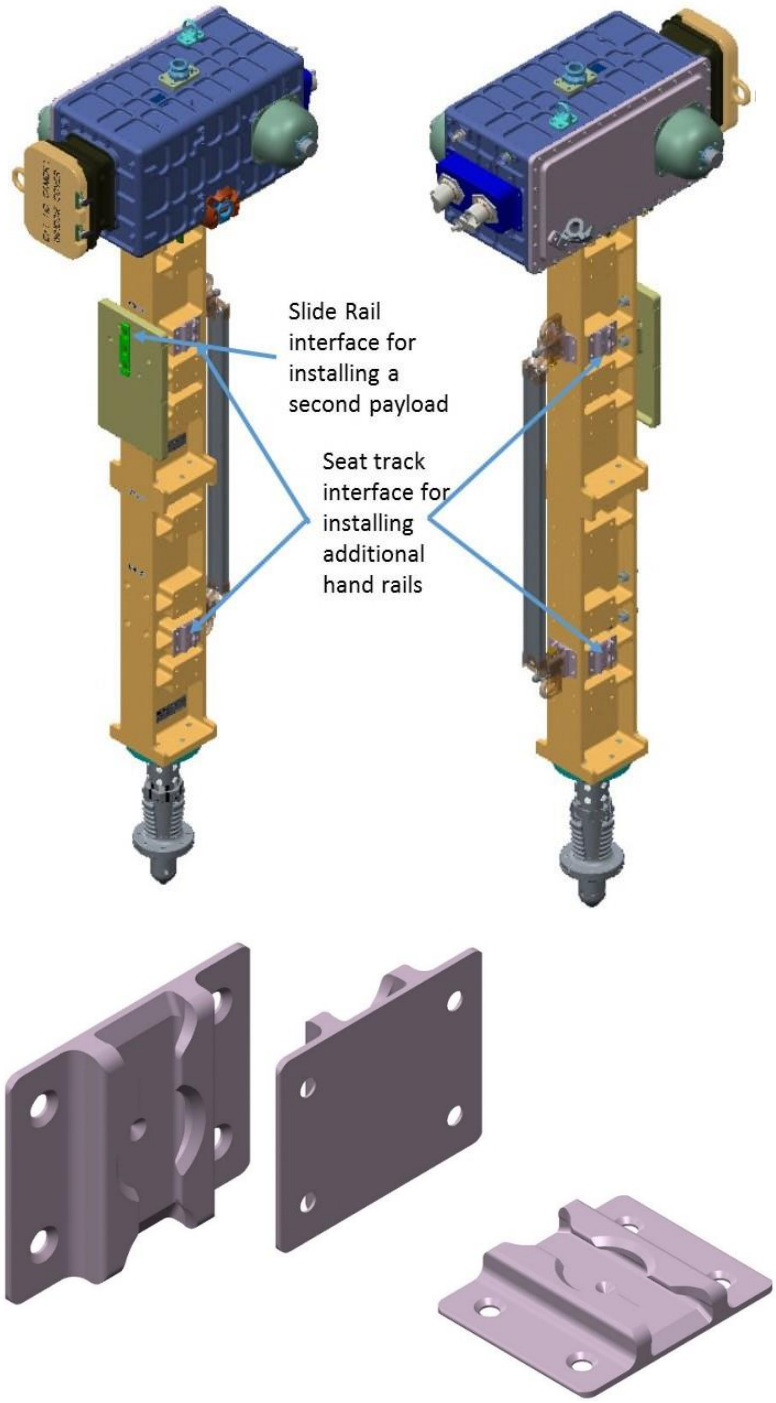


Figure 3-3 Payload Mounting Interfaces

The seat track is built-to-print 683-11167-1 that has been configured on the boom per SSP 30256:001, Revision J. The interfaces are shown in Figures 3-4 and 3-5.

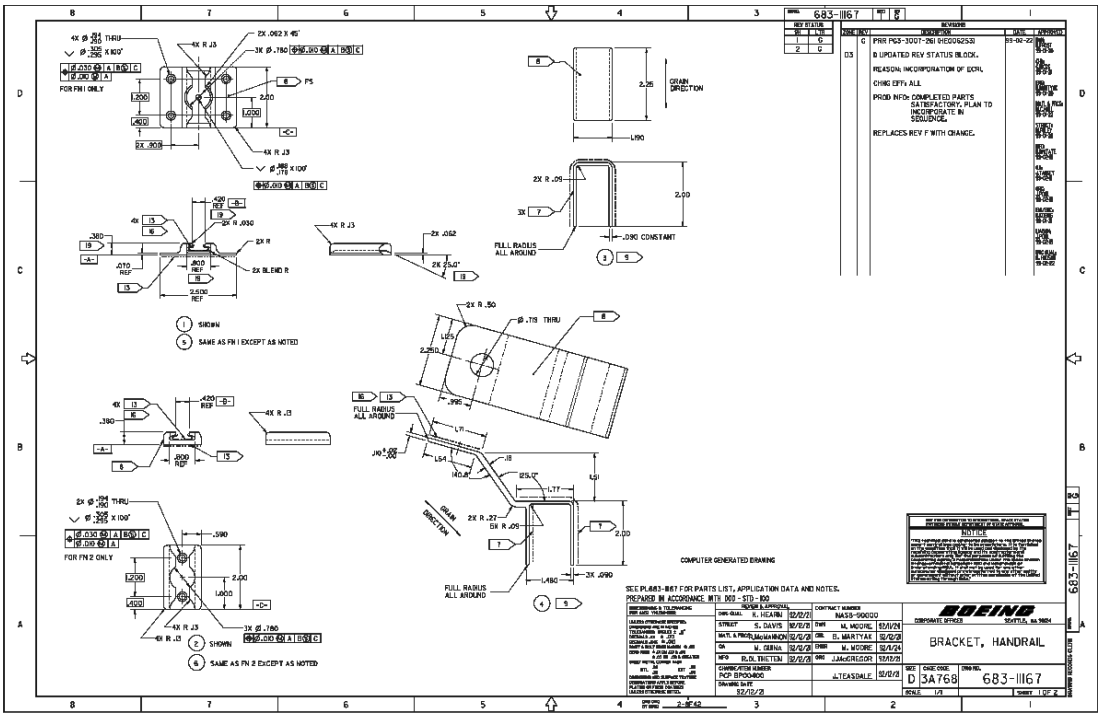


Figure 3-4 Seat Track Design-1

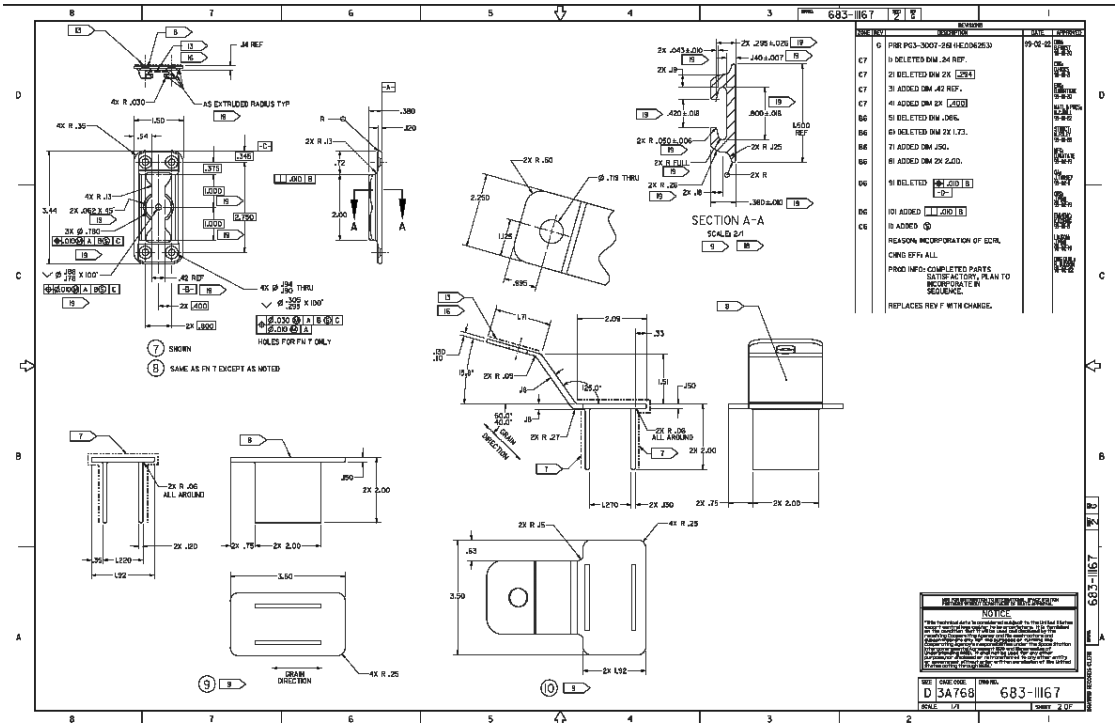


Figure 3-5 Seat Track Design-2

The seat track installation is shown in Figure 3-6.

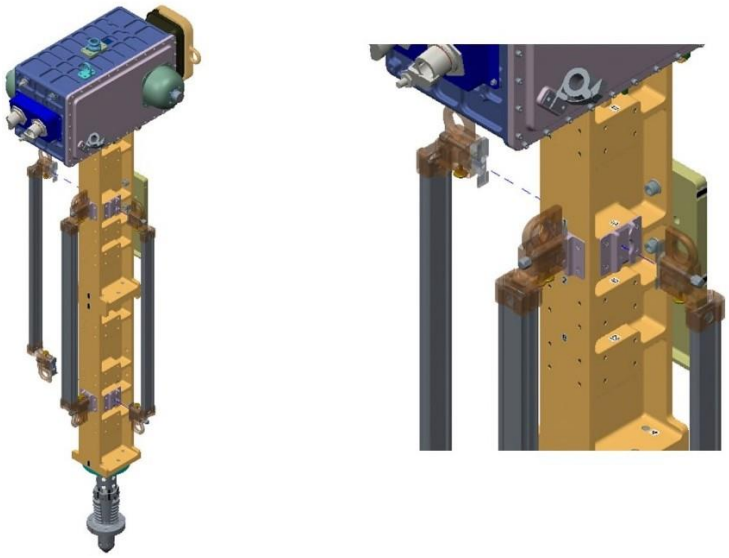


Figure 3-6 Seat Track Installation

The payload attachment interface on the mounting plate is using a slide rail (also known as TVC mounting slide) as per drawing 2292810. The interfaces are provided in Figure 3-7.

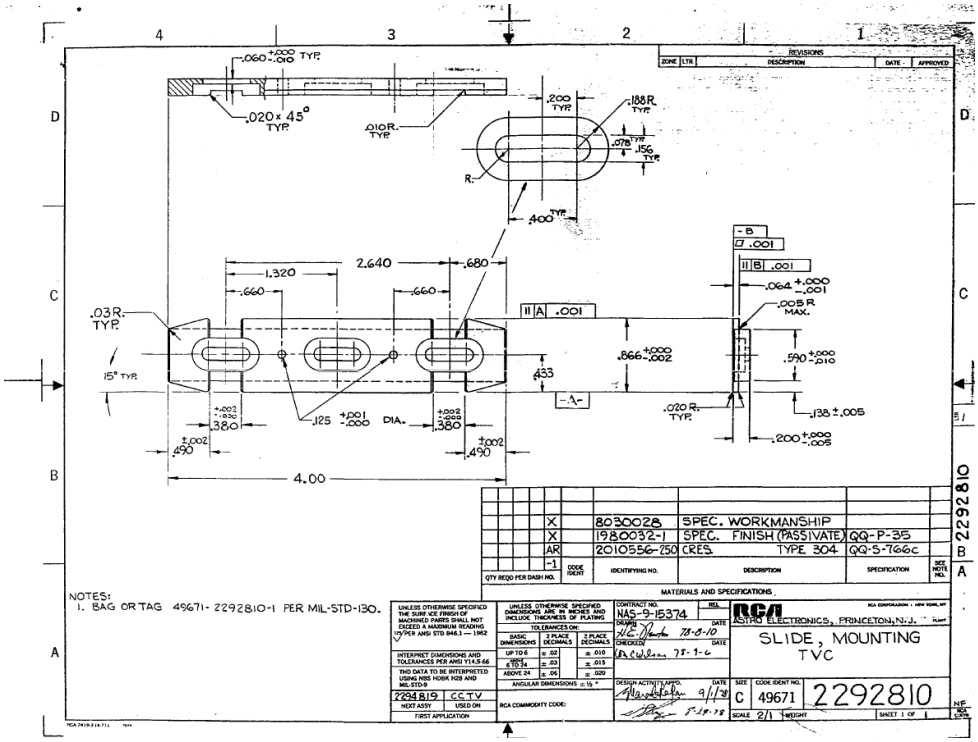


Figure 3-7 EHDC Mounting Slide Rail Interface

The slide rail installation is shown in Figure 3-8.

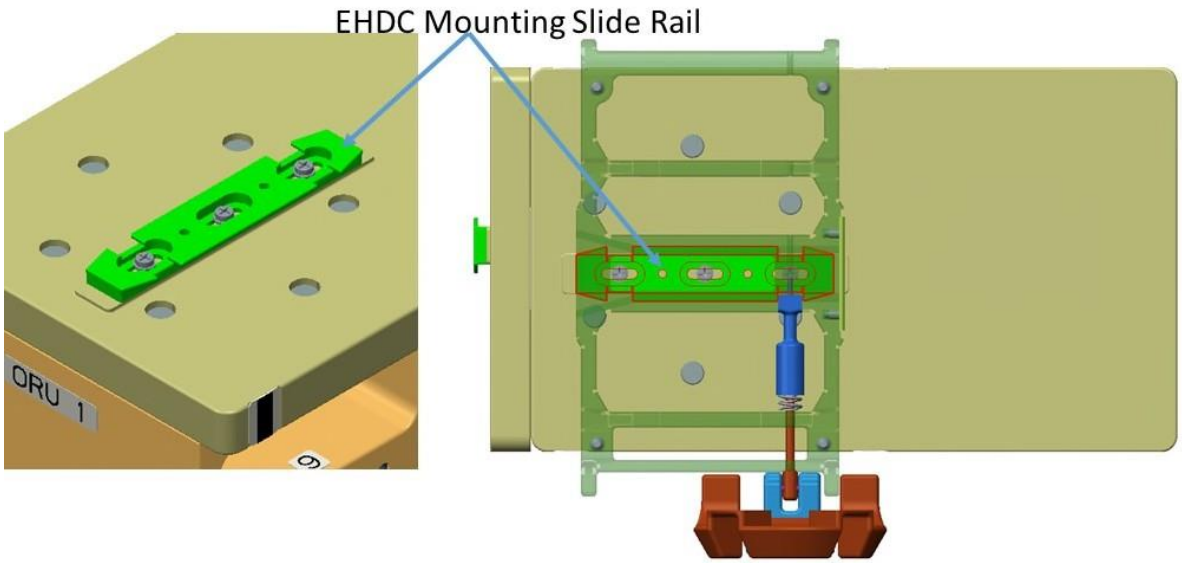


Figure 3-8 Slide Rail Installation

3.2.3.2 Electrical Bonding Interfaces

The boom will provide provisions to meet Class S bonding per SSP 30245, ISS Bonding requirements. This is achieved by multiple alodined faying surfaces. The bonding to the payload is achieved through the slide rail. The slide rail is attached to the mounting plate. The nickel plated faying surface on the mounting plate surface that is underneath the slide rail allows for the EHDC to achieve Class R bond to the Mounting Plate Assembly. The bonding provisions are detailed in Figure 3-9.

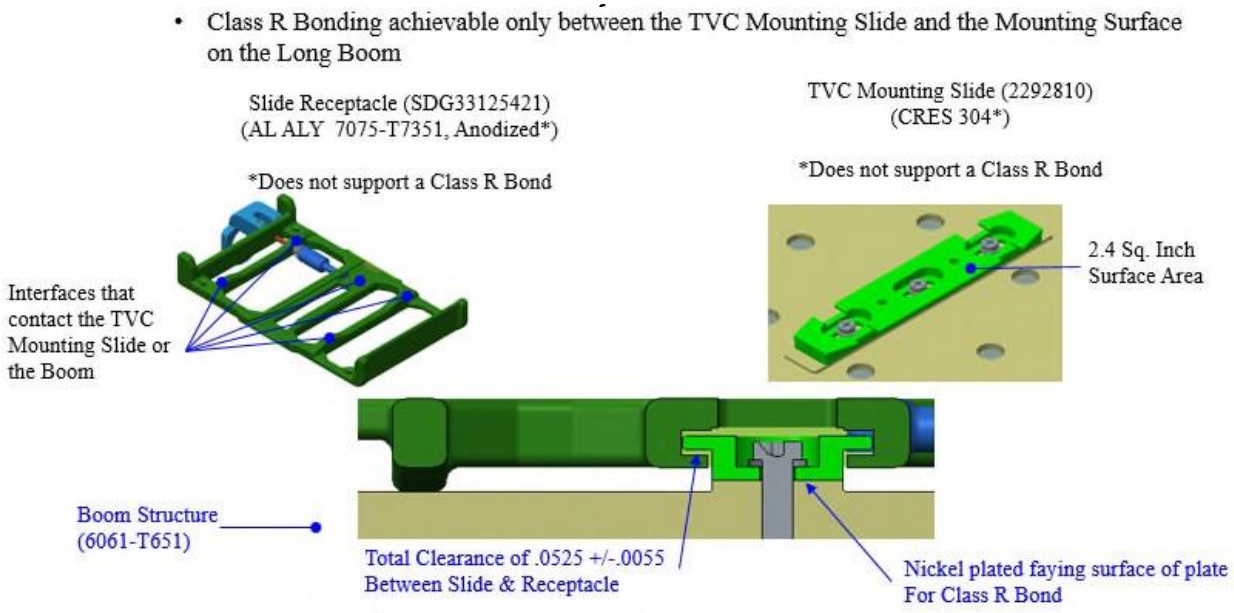


Figure 3-9 Bonding Provisions

3.2.3.3 Envelop Dimensions

The overall envelop dimensions are shown in Figure 3-10. The dimensions shown are for the boom with the additional EDHC and the OIH istalled.

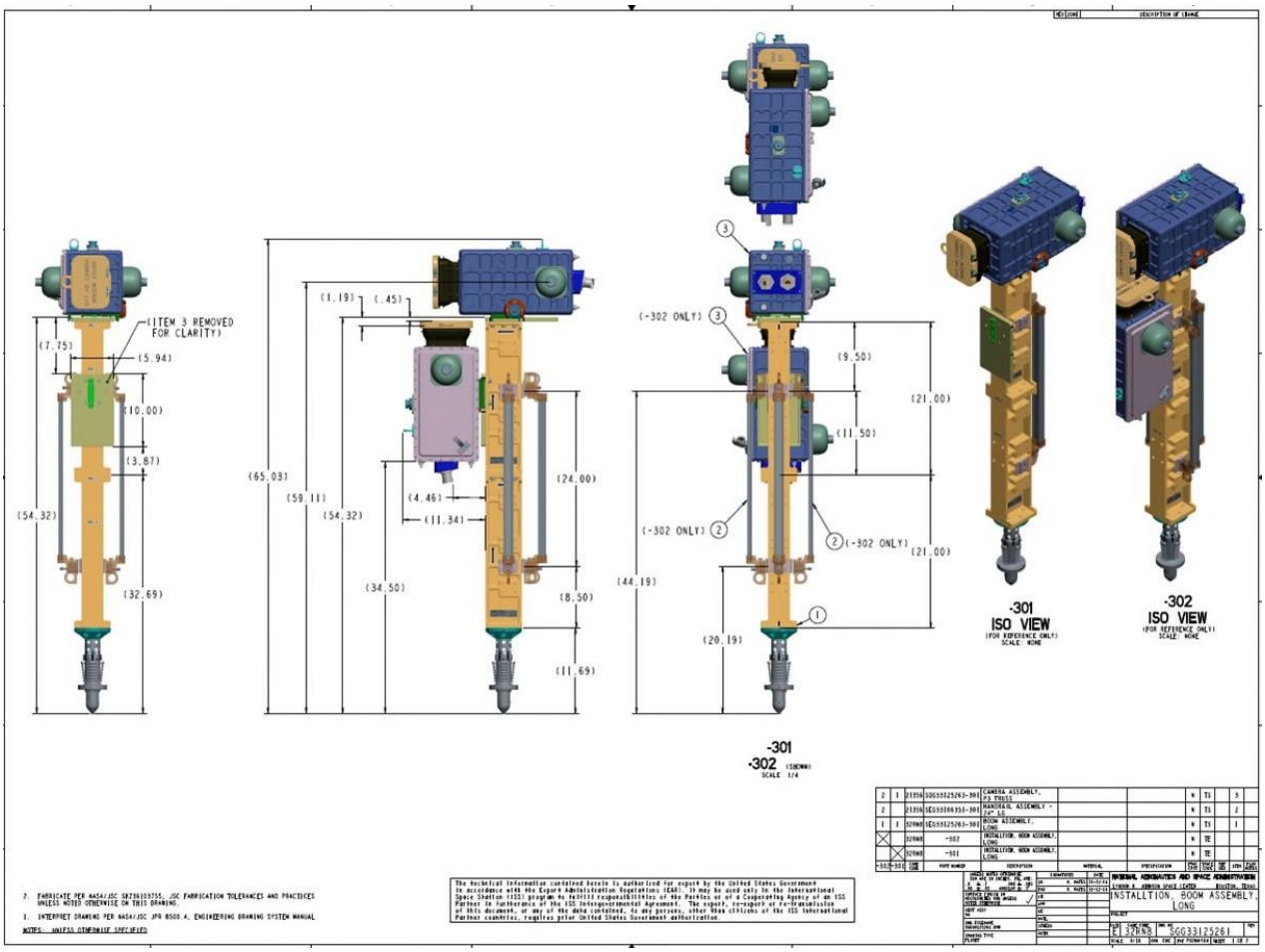
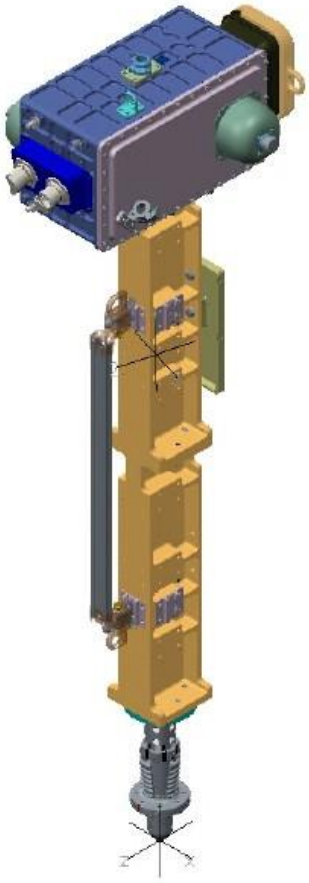


Figure 3-10 Overall Envelop Dimensions

(Dimensions in inches)

3.2.3.4 Mass Properties

The mass properties of the -301 configuration with one EHDC and one OIH are shown in Figure 3-11. The total mass for the -301 configuration is 81.83 lbs. The mass properties of the -302 configuration with two EGDC and three OIH are shown in Figure 3-12. The total mass for the -302 configuration is 114.13 lbs. The component mass break down is shown in Figure 3-13. The origin of the coordinate system is located at the base of the WIF probe as shown the Figure 3-14.

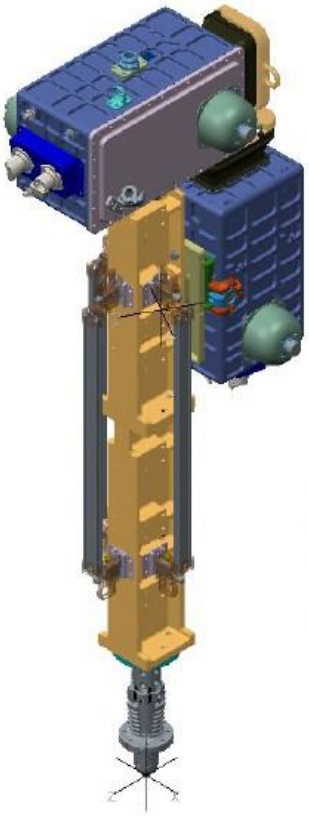


INFORMATION WINDOW (modmass.dat)

File Edit View

```
VOLUME =  6.6311650e+02  INCH^3
SURFACE AREA =  5.3563809e+03  INCH^2
AVERAGE DENSITY =  1.2231463e-01 POUND / INCH^3
MASS =  8.1108851e+01 POUND

CENTER OF GRAVITY with respect to _SGG33125261-301 coordinate frame:
X   Y   Z     1.5986274e-01  4.0045048e+01  5.4774378e-01  INCH

INERTIA with respect to _SGG33125261-301 coordinate frame:  (POUND * INCH^2)

INERTIA TENSOR:
Ixx Ixy Ixz  1.6564453e+05 -6.8470757e+02  5.8345351e+02
Iyx Iyy Iyz -6.8470757e+02  1.0562364e+04 -2.3658861e+03
Izx Izy Izz  5.8345351e+02 -2.3658861e+03  1.6375381e+05

INERTIA at CENTER OF GRAVITY with respect to _SGG33125261-301 coordinate frame:  (POUND * INCH^2)

INERTIA TENSOR:
Ixx Ixy Ixz  3.5553568e+04 -1.6547212e+02  5.9055571e+02
Iyx Iyy Iyz -1.6547212e+02  1.0535957e+04 -5.8681001e+02
Izx Izy Izz  5.9055571e+02 -5.8681001e+02  3.3685189e+04

PRINCIPAL MOMENTS OF INERTIA:  (POUND * INCH^2)
I1  I2  I3   1.0520186e+04  3.3525736e+04  3.5728711e+04

ROTATION MATRIX from _SGG33125261-301 orientation to PRINCIPAL AXES:
       0.00601       -0.28123        0.95962
       0.99967       -0.02246       -0.01285
       0.02517        0.95938        0.28100

ROTATION ANGLES from _SGG33125261-301 orientation to PRINCIPAL AXES (degrees):
angles about x  y  z   2.618         73.663         88.775

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1  R2  R3 1.1388790e+01  2.0330827e+01  2.0988169e+01  INCH
```

Figure 3-11 Mass Properties: -301 Configuration



INFORMATION WINDOW (modmass.dat)

File Edit View

```
VOLUME =  8.7780419e+02  INCH^3
SURFACE AREA =  8.7790230e+03  INCH^2
AVERAGE DENSITY =  1.2931898e-01 POUND / INCH^3
MASS =  1.1341328e+02 POUND

CENTER OF GRAVITY with respect to _SGG33125261-301 coordinate frame:
X   Y   Z     9.0169133e-04  4.0528322e+01 -1.5317722e+00  INCH

INERTIA with respect to _SGG33125261-301 coordinate frame:  (POUND * INCH^2)

INERTIA TENSOR:
Ixx Ixy Ixz  2.9205778e+05  4.6679900e+02  5.6232203e+02
Iyx Iyy Iyz  4.6679900e+02  1.8234495e+04  6.9553134e+03
Izx Izy Izz  5.6232203e+02  6.9553134e+03  2.3115391e+05

INERTIA at CENTER OF GRAVITY with respect to _SGG33125261-301 coordinate frame:  (POUND * INCH^2)

INERTIA TENSOR:
Ixx Ixy Ixz  4.5505262e+04  4.7094358e+02  5.6216539e+02
Iyx Iyy Iyz  4.7094358e+02  1.7968398e+04 -8.5400947e+01
Izx Izy Izz  5.6216539e+02 -8.5400947e+01  4.4867501e+04

PRINCIPAL MOMENTS OF INERTIA:  (POUND * INCH^2)
I1  I2  I3   1.7960883e+04  4.4549695e+04  4.5837456e+04

ROTATION MATRIX from _SGG33125261-301 orientation to PRINCIPAL AXES:
      -0.01717       -0.50042        0.86561
       0.99985       -0.01165        0.01309
       0.00353        0.86571        0.50054

ROTATION ANGLES from _SGG33125261-301 orientation to PRINCIPAL AXES (degrees):
angles about x  y  z  -1.498         59.953         91.965

RADII OF GYRATION with respect to PRINCIPAL AXES:
R1  R2  R3 1.2584073e+01  1.9818061e+01  2.0103806e+01  INCH
```

Figure 3-12 Mass Properties: -302 Configuration

Mass breakdown for the major components of the assemblyis shown in Figure 3-13.

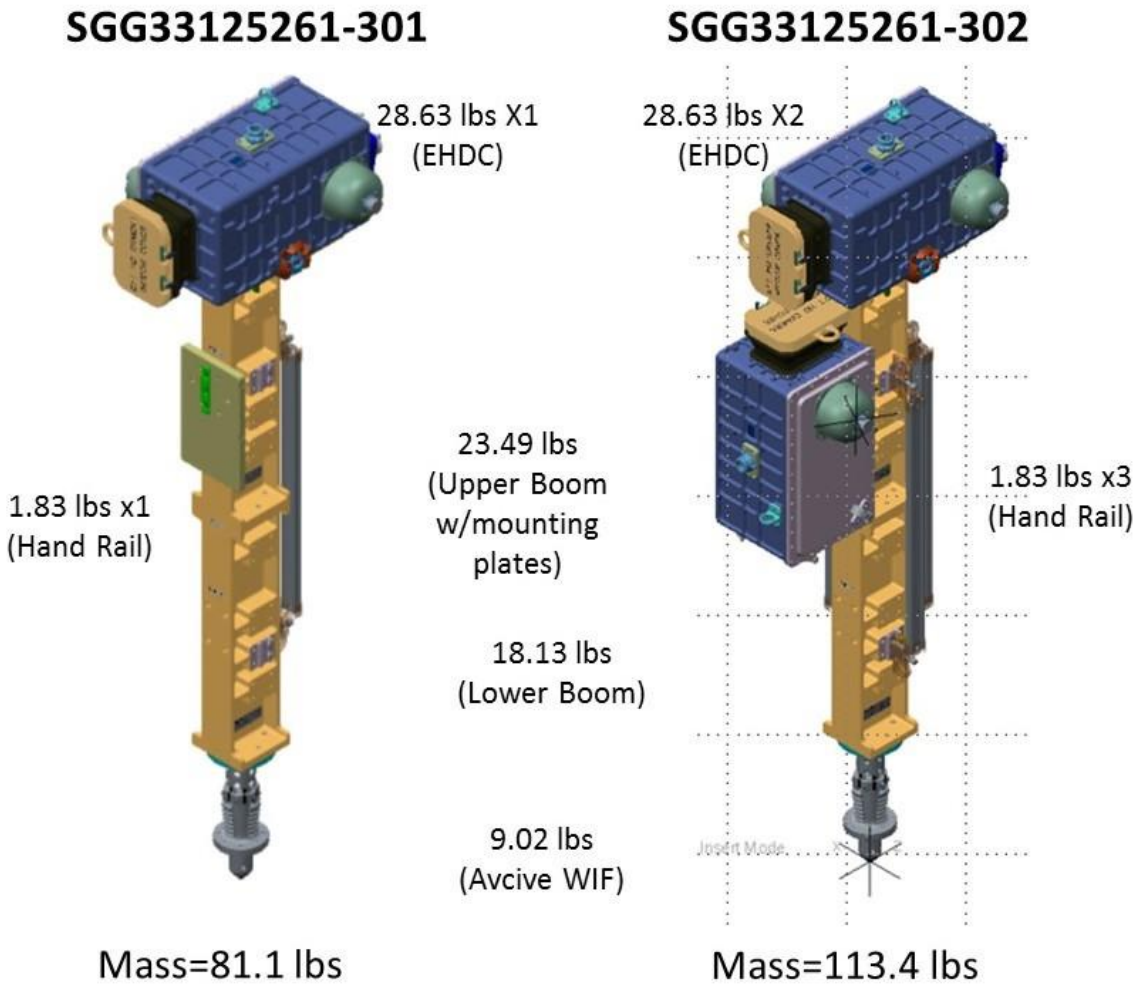


Figure 3-13 Component Mass Break Down

3.2.3.5 Coordinate System Definition

Figure 3-14 shows the coordinate system. The positive Y-axis is along the length of the boom from the WIF as shown in the figure.

Figure 3-14 Coordinate System Definition

3.2.3.6 Interface Loads

The EWC Boom shall support the limit loads induced by an EVA crewmember provided in SSP 30256, Space Station Program Extravehicular Activity (EVA) Standard Interface Control Document, paragraph 3.1.3, Table 3.1.3-1.

Figure 3-15 shows the applicable EVA on-orbit induced loads. The enveloping analysis was performed for the heavier SGG33125261-302 configuration. However, Figures 3-15, 3-16, and 3-17 show the SGG33125261-301 configuration for illustration of load application locations.

The ctitical load-cases are the 125 lbf kick load applied at the extreme location on the EHDC and the 187 lbf secondary tranlastion load applied to the hand rail. These load envelop the inertial on-orbit loads.

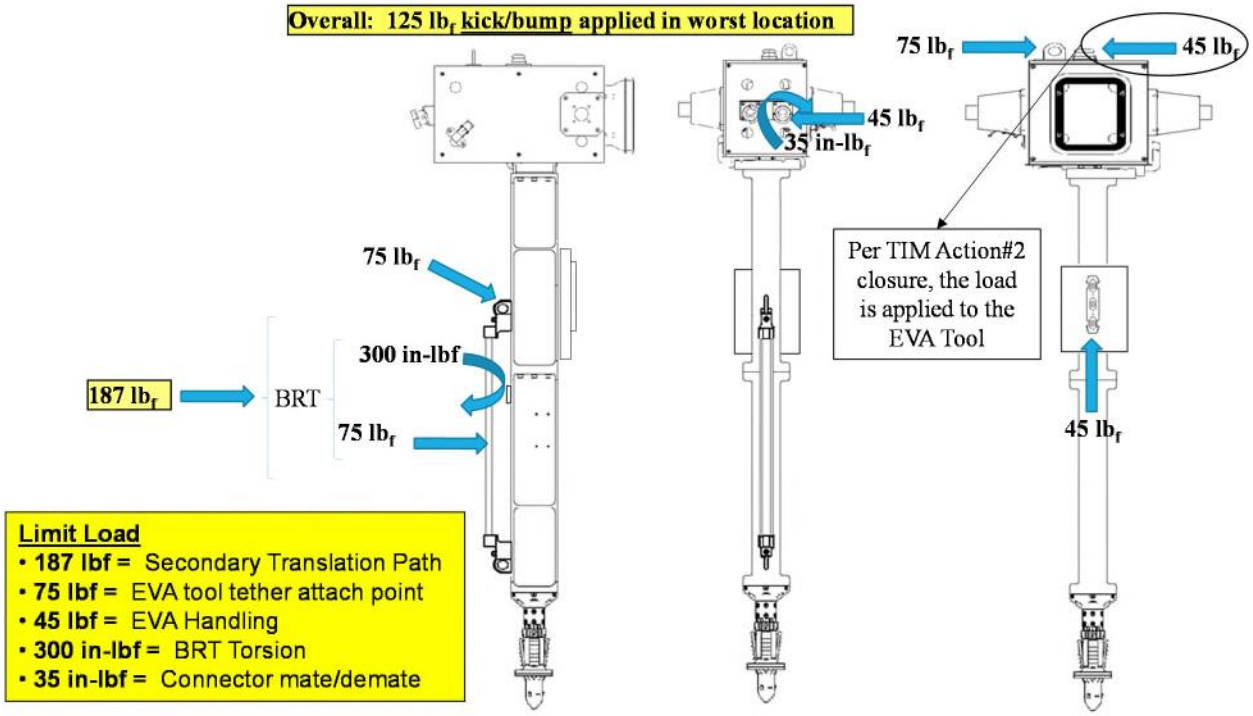


Figure 3-15 EVA Induced Loads

Peak interface forces at the WIF socket are generated by applying 125 lbf kick loads to the extreme location on the boom, and 187 lbf secondary translation path loads on the extreme location on the handrail (see Figure 3-16).

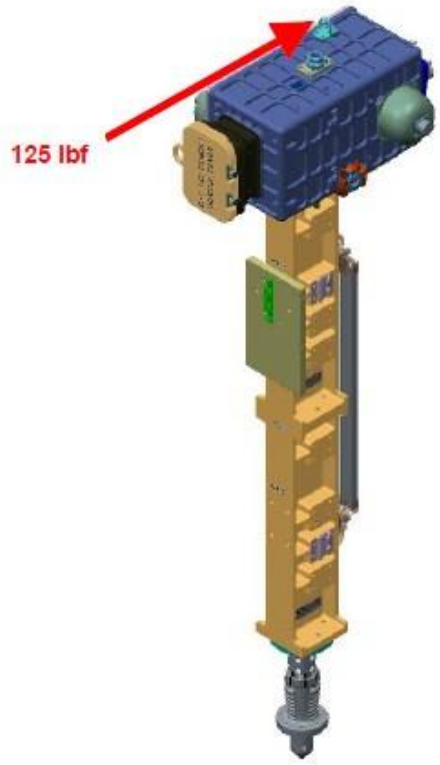


Figure 3-16 125 lbf Kick Load Applied to Extreme Location

The peak interface forces at the WIF socket from applying the 125 lbf kick loads are shown in Table 3-1. There are three cases shown: Maximum moment, maximum torsion/shear, and maximum axial load cases.

Table 3-1 WIF Socket Interface Forces from 125 Lbf Kick Load

Load Component	Max Moment Case	Max Torsion/Shear Case	Max Axial Case	Active WIF Analysis loads-C2V2	Comments
Moment Mxz (in-lbf)	8160	6245	712	8391*	*Ref: CMC2-00226
Torque My (in-lbf)	76	1603	0	6948*	*Ref: CMC2-00226
Axial Fy (lbf)	-11	0	125	131*	*Ref: CMC2-00226
Shear Fxz (lbf)	124	125	0	131*	*Ref: CMC2-00226

The peak WIF socket interface forces for the EWC Long Boom Assembly are enveloped by the interface forces from the P3 CAA (Reference CMC2-00226, Structural Verification Plan for Common Communications for Visiting Vehicles (C2V2) Antenna Assemblies (CAAs) Under Space Station Change Notice (SSCN) 013314, Revision A, Table 7-3).

Interface forces at the WIF socket were also calculated for 187 lbf secondary translation loads to the extreme location on the handrail. The handrail location is shown in Figure 3-17.

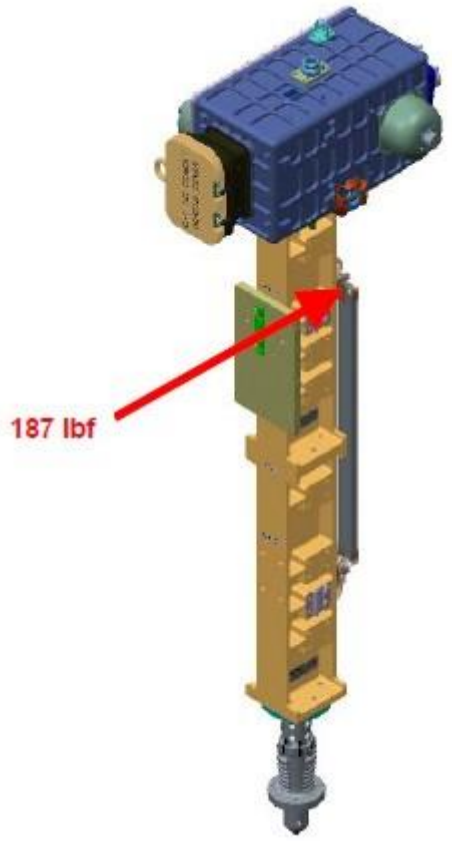


Figure 3-17 187 lbf Secondary Translation Load Applied to Handrail

The peak interface forces at the WIF socket from applying the 187 lbf secondary translation loads are shown in Table 3-2. Again, there are three cases shown: Maximum moment, maximum torsion/shear, and maximum axial.

Table 3-2 WIF Socket Interface Forces from 187 lbf Handrail Load

Load Component	Max Moment Case	Max Torsion/Shear Case	Max Axial Case	Active WIF Analysis loads-C2V2	Comments
Moment Mxz (in-lbf)	8260	8195	1033	8391*	*Ref: CMC2-00226
Torque My (in-lbf)	0	1033	0	6948*	*Ref: CMC2-00226
Axial Fy (lbf)	-23	0	187	131*	*Ref: CMC2-00226
Shear Fxz (lbf)	186	187	0	131*	*Ref: CMC2-00226

3.2.3.7 Thermal Design and Interface Temperature

The temperature at the scarred locations have been determined based on thermal analysis. The locations are shown in Figure 3-18. The temperature data presented is based on thermal analysis peformed for the SGG33125261-301 configuration of the boom assembly.

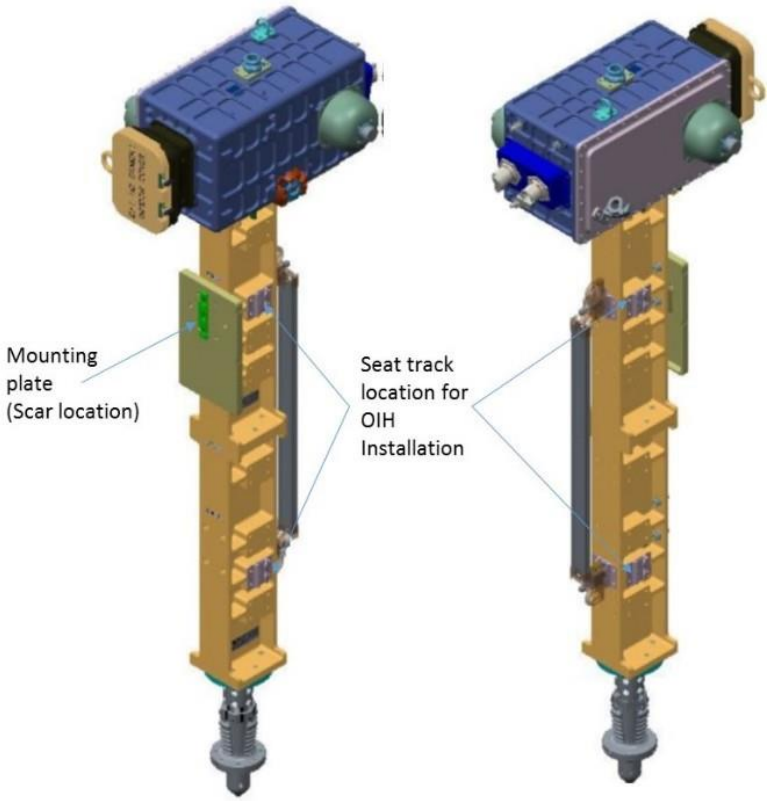


Figure 3-18 Locations for Themperature Definition

The thermal attitude cases that were analyzed for the P3 location of the boom are shown in Table 3-3 and the interface temperatures are shown in Table 3-4. The temperature defined for the scar OIH location is the worst case temperature for the three OIH locations.

Table 3-3 Thermal Analysis Cases-P3 location

Case ID		Attitude				BGAs	PTRRJ	PSARJ	STRRJ	SSARJ
		Y	P	R	Beta					
p3c1	TEA	-4	-2	1	-60	Auto	-40	270	25	90
p3c2	TEA	-4	-2	1	-75	Auto	-40	270	25	90
p3c3	TEA	-4	-2	1	0	Auto	-40	Auto	25	Auto
p3c4	XVV	-15	-20	15	0	Auto	-40	Auto	25	Auto

Case ID		Attitude				BGAs	PTRRJ	PSARJ	STRRJ	SSARJ
		Y	P	R	Beta					
p3c6	-YVV	84	-9	5	-10	Auto	-40	0	25	0
p3c7	ZVV	0	90	0	0	Auto	-40	Auto	25	Auto
p3h1	TEA	-4	-2	1	45	Auto	-40	Auto	25	Auto
p3h2	TEA	-4	-2	1	-45	Auto	-40	270	25	90
p3h3	XVV	15	-20	-15	45	Auto	-40	Auto	25	Auto
p3h5	-YVV	84	1	5	45	Auto	-40	270	25	90
p3h7	ZVV	165	105	15	75	Auto	-40	Auto	25	Auto
p3h8	ZVV	-15	75	15	-60	Auto	-40	Auto	25	Auto

Table 3-4 Temperature Limits-P3 Location

(SGG33125261-301 configuration)

Part	Min Temp °F	Attitude	Max Temp ^{0}F	Attitude
Scar Plate	-47	TEA	146	TEA
Hand rail	-54	ZVV	173	ZVV
Hand rail	-48	-YVV	157	TEA
WIF probe	-30	TEA	137	ZVV
Scar OIH location*	-30		138	

*Minimum/Maximum values

The thermal attitude cases that were analyzed for the S3 location of the boom are shown in Table 3-5 and the interface temperatures are shown in Table 3-6.

Table 3-5 Thermal Analysis Cases-S3 Location

Case ID		Attitude				BGAs	PTRRJ	PSARJ	STRRJ	SSARJ
		Y	P	R	Beta					
s3c1	TEA	-4	-2	1	60	Auto	-40	270	25	90
s3c2	TEA	-4	-2	1	75	Auto	-40	270	25	90
s3c3	TEA	-4	-2	1	0	Auto	-40	Auto	25	Auto
s3c4	XVV	0	-20	0	0	Auto	-40	Auto	25	Auto
s3c6	YVV	-97	-9	5	10	Auto	-40	0	25	0
s3c8	ZVV	0	90	0	0	Auto	-40	Auto	25	Auto
s3h1	TEA	-4	-2	1	-45	Auto	-40	Auto	25	Auto
s3h2	TEA	-4	-2	1	-30	Auto	-40	270	25	90
s3h3	XVV	-15	-20	15	-45	Auto	-40	Auto	25	Auto
s3h5	-YVV	94	1	-5	45	Auto	-40	270	25	90

Case ID		Attitude				BGAs	PTRRJ	PSARJ	STRRJ	SSARJ
		Y	P	R	Beta					
s3h7	ZVV	165	105	15	75	Auto	-40	Auto	25	Auto
s3h8	ZVV	-15	75	15	-60	Auto	-40	Auto	25	Auto

Table 3-6 Temperature Limits-S3 location

(SGG33125261-301 configuration)

Part	Min Temp °F	Attitude	Max Temp ^{0}F	Attitude
Scar Plate	-53	XVV	205	ZVV
Hand Rail	-48	XVV	156	ZVV
WIF Probe	-34	TEA	144	ZVV
Scar OIH location *	-31		144	

*Minimum/Maximum values

3.2.3.8 Touch Temperature Data

All components of the long boom assembly (SGG33125261-301 configuration) meet the incidental touch temperature requirement of -180ºF to +235ºF. The unlimited touch temperature requirement of -45ºF to +145ºF is applicable to the WIF probe and hand rails. The calculated temperatures on the port side boom hand-rail exceeded the unlimited touch temperature limits. These exceedances has been resolved using heat rate calculations. The results are shown in Table 3-7. Since no EVA will be planned with the ISS in the ZVV attitude, the exceedances observed are presented here for information only. The exceedance found in other attitudes are resolved through heat transfer calculations.

Table 3-7 Contact Heat Rate Calculation Results

Location/Part	Max./Min Temp ºF	Allowable Temp. ºF	30 Minute Heat Rate (BTU/Hr)	Heat Rate Limit (BTU/Hr)
Port Side Hand Rail	157	145	11.25	+42.52
Port Side Hand Rail	-48	-45	-31.33	-132.7

4.0 ENGINEERING UNITS, TOLERANCES, AND CONVERSIONS

Unless otherwise noted herein, all dimensions in this document are shown in the English system of inch-pound (in-lbs) units. Dimensions on drawings are interpreted per American Society of Mechancial Engineers (ASME) Y14.5M-1994.

APPENDIX A. ACRONYMS AND ABBREVIATIONS

ASME	American Society of Mechanical Engineers
AWIF	Active Work Site Interface
CG	Center of Gravity
CMC	Cargo Mission Contract
CTVC	Color Television Camera
EHDC	External High Definition Camera
EVA	Extra Vehicular Activity
EWC	External Wireless Communication
EWCCE	External Wireless Communications Coverage Expansion
GFE	Government Furnished Equipment
ICD	Interface Control Document
ICWG	Interface Control Working Group
ISS	International Space Station
IVA	Intra Vehicular Activity
OIH	On-orbit Installed Hand rail
ORU	Orbital Replacement Unit
ORU	Orbital Replacement Unit ()
P3	ISS port side long spacer
POC	Point of Contact
S3	ISS starboard side long spacer
TVC	Television Camera
WIF	Worksite Interface